The Commissioning Process:

In Search of a Universal Definition and Application

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Agenda

- Overview
  - The Current Reality
  - Defining Commissioning
  - The Commissioning Process
- Case Study
  - Pfizer B220

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Why More Focus on Commissioning?

- Challenges created by “speed to market” push
- Focus on maximum building operational efficiency
  - Documented lower life cycle costs/higher operating efficiency through proper Cx
  - 8-10% reduction in Operation Cost
- Owners feel that the construction costs are increasing disproportionately with building performance
- Heightened focus on occupant satisfaction
- Today's building systems/new technologies are more complex & interdependent

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The Current Reality

- A study of 60 newly constructed buildings revealed that:
  - 50% suffered from control problems
  - 40% had HVAC equipment problems
  - 15% had missing equipment
  - 25% had energy management systems, economizers and/or variable speed drives that did not function properly
    - Lawrence Berkeley National Laboratory, 1996

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The Current Reality

- Definitions and Expectations vary
  - Commissioning vs. validation
  - What systems should be included?
- Can become a “stepchild” of the design & construction process
  - Funding allocated – spent on other “priorities”
- Even R&D and process facilities do not always take an “Integrated System Cx” approach

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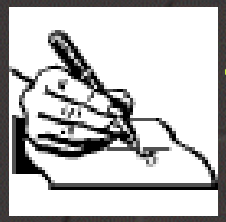
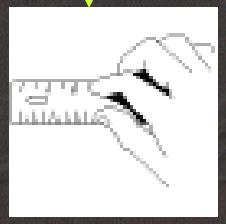
The Current Reality

- Linear process with little collaboration



Owner develops requirements



A/E develops technical specifications

Builder implements series of tests at the end of the project

FM/O&M staff trained afterwards and given manuals

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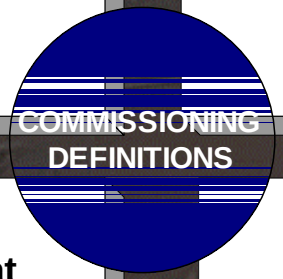
Defining Commissioning

ASHRAE: a quality-oriented process for achieving, verifying, and documenting that the performance of facility systems and assemblies meet defined objectives and criteria.

USDOE: a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner's operational needs.



NIBS: the systematic process of ensuring that performance of the facility and its systems meet the functional and operational needs of the owner and occupants.

ISPE: well planned, documented, & managed eng'ing approach to start-up & turnover of facilities, systems, & equip. to End-User that results in a safe & functional env. that meets estab'ed design req's & stakeholder expectations.

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Defining Commissioning

- Our consensus:
  - A *well-planned, documented and managed* approach to the *installation, start-up, turnover and verification* of facilities, systems and equipment to the end-user which results in a *safe, productive environment* that meets the *designers intent* and the owner's *quality expectations*.

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Commissioning Objectives

- Document Owner's goals & requirements
- Establish "common success criteria"
- Keep project team focused on owner's goals & success criteria
- Verify and document that building systems meet owner's intent & need
- Train facilities personnel to properly operate & maintain the systems
- Increase operational efficiency

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Design Phase

- Work with Team to determine requirements/Document design intent (BOD)
- Review Design Documents (SD, DD, CD)
- Develop Commissioning Plan and Schedule with the Team
- Develop written protocols
- Develop Technical Specifications for incorporation into “buy-out” documents

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Construction & Turnover Phase

- Develop commissioning sequences
- Review submittals
- Schedule, coordinate and document system testing (TAB, etc.)
- Perform additional functional performance testing
- Provide O&M training
- Coordinate turn-over activities

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During Operation

- Perform any required seasonal testing & training
- Review equipment and system performance prior to warranty period expiration
- Conduct a “Lessons Learned” session
- Provide trouble shooting support

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The Commissioning Team

- Owner Representatives
- Design Professionals
- Construction Manager
- Commissioning Authority/Agent
- Suppliers / Equipment Manufacturers
- O&M Representatives
- Trade Contractors

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Responsibilities

Legend: D = Develop R = Review A = Approve E = Execute	Commissioning Agent
Design CPA	-
RFP for Commissioning Agent Services	-
Design Documents • Schematic Documents • Design Documents • Construction Documents	R
Develop Commissioning Schedule	D
Develop Estimate For Full Commissioning Plan Including Implementation Costs	D
Pre-construction Services • Estimating • Scheduling • Buy Out	R
Definitive CPA	R
Develop Project Specific Commissioning Plan	D & E
Pre-Delivery Inspection (PDI) Plan	D & E
Pre-Delivery Inspection (PDI) Report	D & E
Factory Acceptance Test (FAT) Plan	D & E
Factory Acceptance Test (FAT) Report	D & E
Construction	R
Implement Commissioning Plan (perform tests)	E
Steady State ("Burn In")	R
Deliverables • Commissioning Report • As-Built Drawings • O & M / Turn Over Documents • Warranties • Manuals	D & E
Training • Facilities Management/Users	D & E
Final Commissioning Summary Report	D & E
Post-Acceptance Commissioning	-

Legend: D = Develop R = Review A = Approve E = Execute	Owner's Project Manager	Facility Manager	Architect/Engineer	Owner Stakeholders (Users, EHS, etc.)	Construction Manager (Builder)
Design CPA	D	R	R	R	-
RFP for Commissioning Agent Services	D & E	D	R	D	R
Design Documents • Schematic Documents • Design Documents • Construction Documents	A	R	D	R	R
Develop Commissioning Schedule	D	D	D	D	D
Develop Estimate For Full Commissioning Plan Including Implementation Costs	A	D	R	R	R
Pre-construction Services • Estimating • Scheduling • Buy Out	A	R	R	R	D & E
Definitive CPA	D & E	R	R	R	R
Develop Project Specific Commissioning Plan	D & A	D	R	D	R
Pre-Delivery Inspection (PDI) Plan	A	A	R	R	R
Pre-Delivery Inspection (PDI) Report	A	A	R	R	R
Factory Acceptance Test (FAT) Plan	A	A	R	R	R
Factory Acceptance Test (FAT) Report	A	A	R	R	R
Construction	R & A	R & A	R	R	E
Implement Commissioning Plan (perform tests)	R	A	R	E	E
Steady State ("Burn In")	R	A & E	R	A & E	R
Deliverables • Commissioning Report • As-Built Drawings • O & M / Turn Over Documents • Warranties • Manuals	R & A	R & A	D & E	R	D & E
Training • Facilities Management/ Users	R	A & E	R	R	D & E
Final Commissioning Summary Report	A	A	R	R	R
Post-Acceptance Commissioning	R	D & E	-	D & E	-

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Case Study – *Pfizer B220*

- 600,000 SF
- 800-plus Occupants
- $50 Million-plus M/E/P Systems
- 7,000-plus Fan / Pump Horsepower
- 65 VFDs
- 450 Lab Hoods

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Lab Compressed Air

- Field testing revealed a susceptibility to loss of cooling water
- System was modified to ease maintenance and reduce downtime during maintenance

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Lab Vacuum Systems

- Field testing revealed a problem with exhaust backpressure that caused safety trip shutdowns at higher loads
- System has modified to meet design criteria
- Users wanted a deeper, higher volume vacuum that the system could not provide even though design criteria was clear

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Chilled Water

- 6600 tons – 14,000 GPM @ 42F
- System automatically diverts to “free cooling” mode at 47F outside air and isolates from the campus supply
- Testing revealed need for rapid transition to maintain space temperatures; campus system required a slow transition so as not to impact chillers
- Sequence of operation was modified to protect the campus system with minimal impact to control

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Steam Systems

- 140,000 #/HR – Five PRVs
- Testing saw excessive AHU tripping on low temperature detectors in the 1st heating season
- Control strategies had to be modified to allow for a compromise between time to control at startup & tight control in steady state operation
- Research also indicated the need for additional drip traps, which helped solve the problem
- Problem was solved in the 1st season rather than lingering
- Information provided to designers re existing steam supply did not prove out

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Manifolded Air Handlers

- 3 Units - >150,000 CFM delivered
- Pressure relief doors caused problems with pressure controls and related safeties
- Testing revealed a need to modify control strategies to suit both a rapid startup (e.g. restarting 1 unit after PM) and steady state control

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Vivarium Controls

- Each room (>100)– individual T/RH/dP
- User introduced a 30 day “burn-in” requirement that was not part of the original Commissioning program and not in the schedule
- Combined accuracies of related controls (AHU through local) meant a practical limit on humidity available for many rooms that was not anticipated

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Manifolded Lab Exhaust Systems

- 7 fans / > 400,000 CFM
- Field testing indicated problems with the automatic restart (one or more fans) sequence
- Sequence was revised to improve reliability and revise the automatic backup (running backup is now “rested”)

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Lessons Learned

- Phased occupancy of a Commissioned building means retesting and disruption to occupants of the earlier phases
- Accurate information on the existing utilities to serve the building is critical to successful operation
- Lab hood flow measurement needs to account for accuracies of available controls & test equipment
- Users must clearly understand the design criteria – so that there are no surprises at occupancy & systems do what they need to do

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